SPARSE DATA ASSIMILATION IN BRAIN DEFORMATION MODELING

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Image-guided neurosurgery involves using patient images acquired before the procedure as a navigational aid in the operating room (OR). The accuracy of these systems can be challenged by the fact that in cases with large surgical openings, the brain deforms throughout the procedure due to a variety of causes, including the loss of cerebral spinal fluid, the removal of unhealthy tissue, or the retraction of tissue to gain access to deeper regions. As a result, the preoperative images are no longer a reliable representation of the brains shape. To address this issue, a biomechanical model based on consolidation physics has been developed to estimate tissue deformation. Intraoperative imaging devices such as ultrasound or digital stereo pairs offer the opportunity to obtain sparse measurements of tissue displacement, which can be used to improve the model estimates. Recognizing this data assimilation as an inverse problem, we seek to find the forcing conditions that minimize the model-data misfit. The problem has been described by the adjoint model, and the representer approach has been used to solve the equations. Initial results from simulated data demonstrate that the inverse model can reproduce the forward model solution to within an average of 0.5 mm. The model has also been applied to clinical data, with promising qualitative results.